US010161583B1

(12) **United States Patent**
Stobart et al.

(10) **Patent No.: US 10,161,583 B1**
(45) **Date of Patent: Dec. 25, 2018**

(54) **LED FLAME EFFECT LIGHTING DEVICE**

(71) Applicant: **Smart Garden Products Ltd.**, Abingdon, Oxfordshire (GB)

(72) Inventors: **Jonathan Stobart**, Longworth (GB); **Stuart Glennerster**, High Wycombe (GB)

(73) Assignee: **Smart Garden Products Ltd.**, Oxfordshire (GB)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/708,897**

(22) Filed: **Sep. 19, 2017**

(51) **Int. Cl.**

F21V 3/02	(2006.01)
F21S 10/04	(2006.01)
F21V 3/00	(2015.01)
F21V 23/00	(2015.01)
F21S 9/03	(2006.01)
F21Y 115/10	(2016.01)
F21V 17/16	(2006.01)

(52) **U.S. Cl.**
CPC ***F21S 10/043*** (2013.01); ***F21S 9/037*** (2013.01); ***F21V 3/00*** (2013.01); ***F21V 23/005*** (2013.01); *F21V 17/16* (2013.01); *F21Y 2115/10* (2016.08)

(58) **Field of Classification Search**
CPC F21S 10/043; F21S 9/037; F21V 3/00; F21V 23/005; F21V 17/16
USPC 362/183
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,081,568	A *	1/1992	Dong	F21L 4/02 362/184
5,924,784	A *	7/1999	Chliwnyj	F21S 9/02 307/64
7,850,346	B1 *	12/2010	Lauer	F21S 10/04 362/272
8,408,746	B1 *	4/2013	Lauer	F21S 8/065 362/271
9,080,736	B1 *	7/2015	Salzinger	H05B 37/0218
2003/0072154	A1 *	4/2003	Moore	F21S 10/04 362/234
2004/0223326	A1 *	11/2004	Wainwright	F21S 6/001 362/231
2007/0139949	A1	6/2007	Tanda et al.	362/551
2011/0063833	A1	3/2011	Chou et al.	362/235
2012/0201022	A1	8/2012	van de Ven et al.	115/10
2013/0070446	A1 *	3/2013	Chen	F21L 4/02 362/183
2015/0043227	A1 *	2/2015	Yang	F21V 19/0025 362/382
2016/0057829	A1	2/2016	Li	33/827
2017/0191632	A1 *	7/2017	Li	F21S 10/043

(Continued)

FOREIGN PATENT DOCUMENTS

CN	206001393	8/2017	F21K 9/23
GB	2527606	12/2015	

OTHER PUBLICATIONS

International Search Report for EP 18178195.2 dated Sep. 2018.

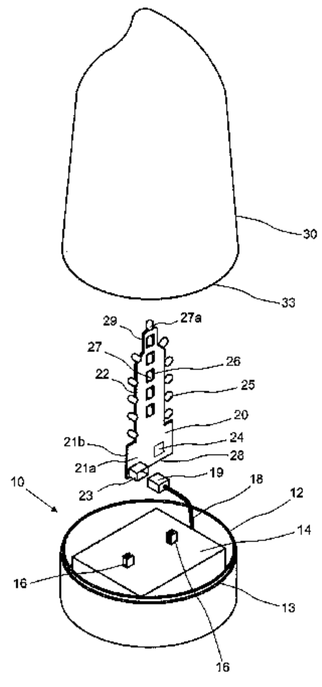
Primary Examiner — Claude J Brown

(74) *Attorney, Agent, or Firm* — MacCord Mason PLLC

(57) **ABSTRACT**

There is provided a lighting device comprising a plurality of light emitting diodes (LEDs) that simulate a flame. The device comprises a circuit board having a plurality of through-holes extending between two opposing faces of the circuit board, and wherein at least some of the LEDs are mounted inside the through-holes so they are visible from both faces of the circuit board.

13 Claims, 2 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0066811	A1*	3/2018	Knapp	F21K 9/68
2018/0163937	A1*	6/2018	Lee	F21S 10/043

* cited by examiner

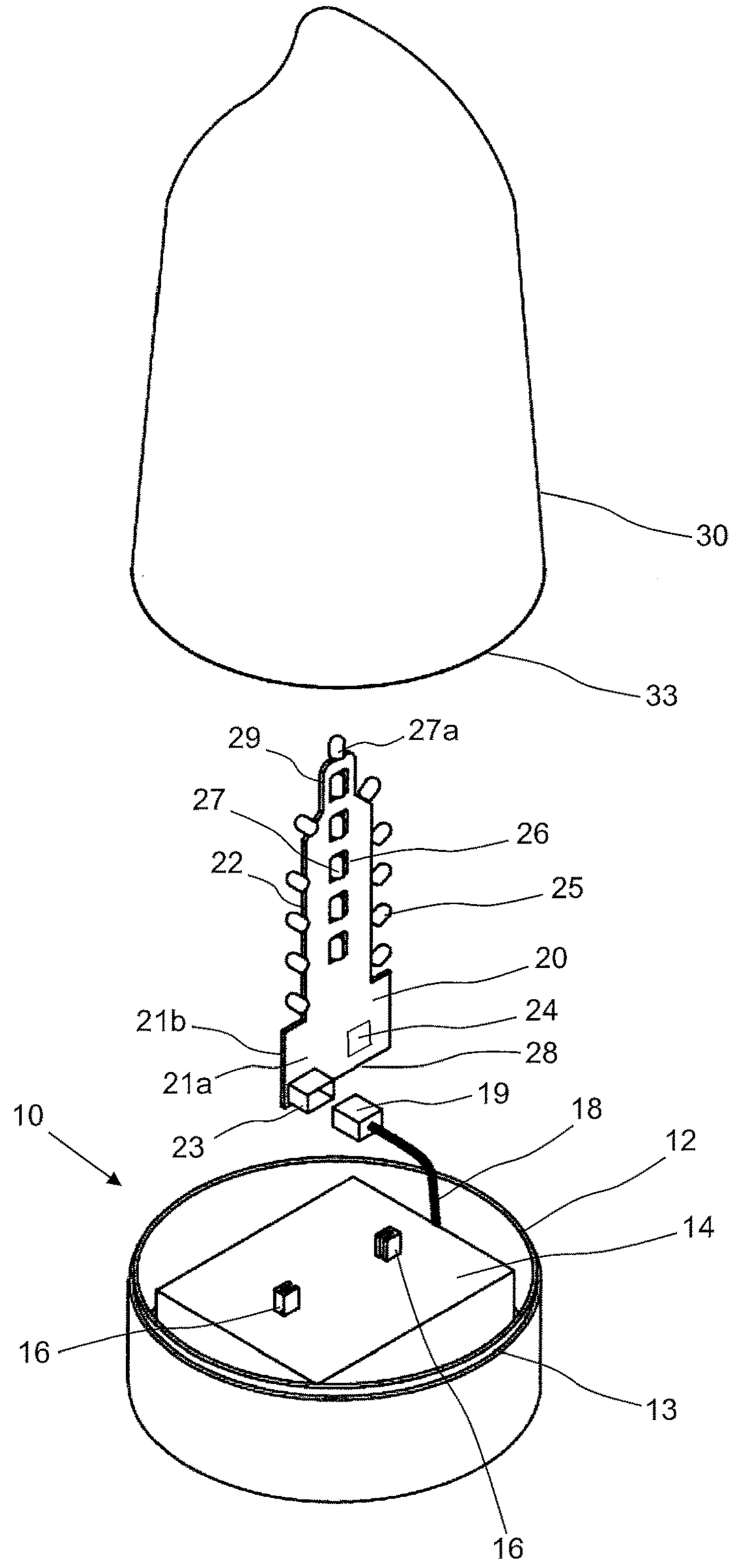


FIG. 1

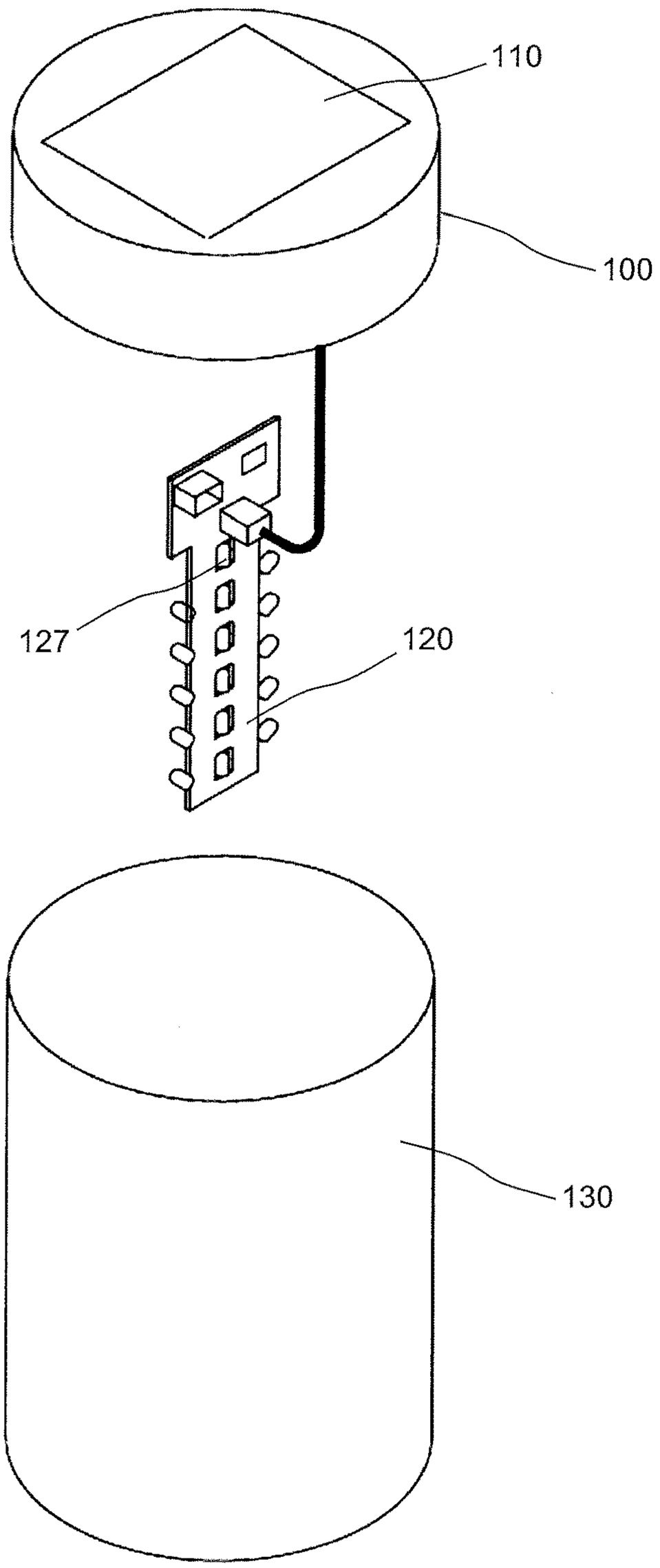


FIG. 2

LED FLAME EFFECT LIGHTING DEVICE

This application claims the benefit of GB 1710069.4 filed 23 Jun. 2017.

DESCRIPTION

The present invention relates to a lighting device comprising a plurality of Light Emitting Diodes (LEDs) that simulate a flame; for example, a flaming torch.

BACKGROUND OF THE INVENTION

It is known to produce lighting devices that incorporate LEDs which simulate a flame. For an effective simulation, the lighting device needs to produce a flame-like light which looks like a flame regardless of which direction the lighting device is viewed from.

The German Utility Model DE 202015107152U describes an LED simulation candle where a bottom circuit board is attached horizontally to a base, and three circuit boards with LEDs are vertically soldered to the bottom circuit board at 120 degrees to one another so the flame effect can be seen from any direction.

However, this construction is complex and requires manufacture of multiple circuit boards in order to provide a flame effect that can be seen from all viewing angles.

It is therefore an object of the invention to improve upon known LED simulation flames.

SUMMARY OF THE INVENTION

According to the invention, there is provided a lighting device comprising a plurality of LEDs that simulate a flame. The device comprises a circuit board having a plurality of through-holes extending between two opposing faces of the circuit board, and at least some of the LEDs are mounted inside the through holes so they are visible from faces of the circuit board.

By mounting the LEDs in through-holes, or in other words holes that go all the way through the circuit board, the LEDs become visible on both sides (faces) of the circuit board, without needing to provide multiple circuit boards.

Preferably, a diffusion envelope is mounted on an end cap of the lighting device, and envelops the circuit board so that it diffuses light from the LEDs. Then, the LEDs do not look like point sources of light from outside the envelope and the flame effect is created more effectively.

The plurality of through-holes preferably comprise a line of at least three through-holes in which LEDs are mounted along an axis of symmetry of the circuit board, for example along a central vertical axis of the circuit board, so that the center of the flame is well defined.

An LED driver for powering the LEDs may be mounted on the same circuit board as the LEDs to avoid the need for any additional circuit boards, further reducing the cost of manufacturing the lighting device. The LED driver preferably switches or modulates the powers sent to the LEDs to simulate a flickering flame, for example a candle flame. The plurality of LEDs may comprise at least two groups of LEDs, and the LED driver may switch or modulate the powers sent to the groups of LEDs to light the groups of LEDs at different times to one another.

To help improve the flame effect when the circuit board is viewed from a peripheral side edge of the circuit board, some of the LEDs may be mounted at the peripheral side, and so are visible from the peripheral side and from both faces of the circuit board. The two opposing faces may each be in the shape of a flame, wherein the peripheral side extends all around the flame shape. The LEDs mounted to the peripheral side are preferably spaced around at least 180 degrees of the circuit board periphery, so the flame shape can be discerned when the LEDs are lit. The flame shape may be a candle flame shape, and a candle flame shape is generally understood to be a roughly rectangular shape with a height at least twice its width and optionally narrowed towards the top of the candle flame shape.

DETAILED DESCRIPTION

Embodiments of the invention will now be described by way of non-limiting example only and with reference to the accompanying drawings, in which:

FIG. **1** shows an exploded schematic perspective diagram of a lighting device according to a first embodiment of the invention; and

FIG. **2** shows an exploded schematic perspective diagram of a lighting device according to a second embodiment of the invention.

The lighting device of the first embodiment has an end cap in the form of a base **10** comprising a circular outer housing **12** and an inner platform **14** inside the housing **12**. The base also comprises a power supply cable **18**, which terminates in a plug **19**. The power supply cable **18** is connected to a battery (not shown) inside the platform **14**. Optionally, the battery may be rechargeable, and if so then the base **10** may have a charging jack for receiving electrical power to recharge the battery. Alternatively, the battery could be omitted entirely, and the power supply cable may be connected to a jack socket in the base for receiving electrical power from an external source.

The lighting device also comprises a circuit board **20**, which is in the shape of a candle flame. The circuit board shape is roughly rectangular with a height greater than twice its width, and the width of the rectangular shape is narrowed at the top **29** of the circuit board. In this embodiment, the circuit board is a printed circuit board (PCB).

The circuit board **20** has first and second faces **21***a* and **21***b*, which are opposite to one another, and in parallel, separated by the thickness of the circuit board. The circuit board has a peripheral side **22** extending all the way around the circuit board and adjoining from the first face to the second face.

The first face **21***a* has a socket **23** for receiving the plug **19** of the power supply from the base. The circuit board includes conductive tracks (not shown for clarity) that carry the power from the socket **23** to an LED driver **24** on the first face **21***a*.

The circuit board **20** also has five through-holes **26** which extend all the way through the thickness of the circuit board and its faces. The through-holes **26** are arranged centrally along the circuit board in a vertical line, and each one of the through-holes has a single corresponding LED **27** inside of it. The LEDs **27** are electrically connected to the LED driver **24** via conductive tracks (not shown for clarity) of the circuit board **20**. The LEDs **27** are visible from both faces **21***a* and **21***b* of the circuit board, via the through-holes **26**.

The circuit board **20** also has eleven LEDs **25** spaced apart from one another around the peripheral side **22**. The LEDs **25** are also electrically connected to the LED driver **24** via conductive tracks (not shown for clarity) of the circuit board **20**. The LEDs **25** are also visible from both faces **21***a* and **21***b* of the circuit board, since they extend beyond the peripheral edge **22**, and so are not obscured from view by the

circuit board **20**. The LEDs **25** and **27** together form a flame shape when they are lit, and the flame shape can be seen from substantially all viewing angles.

The inner platform **14** of the base has two clips **16**, and a lower part **28** of the peripheral side **22** of the circuit board fits into the clips **16** to retain the circuit board **20** to the base **10**.

The circular outer housing **12** has a stepped portion **13** running around the upper circumference of the housing **12**, and a bottom edge **33** of a diffuser **30** is a friction fit over the top edge of the outer housing **12**, and rests on the stepped portion **13**. The diffuser **30** envelopes the circuit board **20** inside the diffuser, and light from the LEDs is diffused by the diffuser so that the LEDs do not look like point sources of light when viewed from outside the diffuser.

In use, the LED driver **24** sends power to the LEDs **25**, **27** to light them and so to simulate a flame. The LEDs are split into groups and the LED driver switches the various groups of LEDs on and off at differing times to one another to simulate a flickering flame torch or candle. Optionally, a Universal Serial Bus (USB) jack could be provided on the base **10** to provide power and/or control, for example to specify how the LED lights should be controlled by the LED driver. The USB jack may power the power supply cable **18** directly, or the USB jack may be used to recharge a battery for powering the power supply cable **18**.

The lighting device of the second embodiment shown in FIG. **2** has an end cap in the form of a top **100**. The top **100** is substantially the same as the base **10** of the first embodiment, except for that it further includes a solar panel **110** on its top surface. In the second embodiment, the solar panel **110** is used to recharge the battery inside the platform of the top **100**.

A circuit board **120**, which is similar to the circuit board **20** of the first embodiment, is held by the top **100** using clips on a platform of the top **100**, in the same manner as the clips **16** of the platform **14** hold the circuit board **20** of the first embodiment. The circuit board **120** differs from the circuit board **20** in that the circuit board **120** has the LED's arranged the opposite way up compared to the circuit board **20**, so that the flame still appears the right way up even although the circuit board orientation is inverted in the second embodiment. For example, the LED **127** adjacent the socket and LED driver of the circuit board simulates the tip of the flame in the second embodiment, whereas the LED **27***a* at an opposite end of the circuit board from the socket and LED driver simulates the tip of the flame in the first embodiment.

A diffuser **130** connects to the top **100** and envelopes the circuit board **120** within it, similar to the diffuser **30** of the first embodiment.

Many other variations of the described embodiments falling within the scope of the appended claims will be apparent to those skilled in the art.

The invention claimed is:

1. A lighting device comprising a plurality of Light Emitting Diodes, LEDs, that simulate a flame, wherein the device comprises a circuit board having a plurality of through-holes extending between two opposing faces of the circuit board, wherein:

some of the LEDs are mounted inside the through holes so they are visible from both faces of the circuit board

the circuit board comprises a peripheral side extending between the two opposing faces, and some of the LEDs are mounted at the peripheral side and so are visible from both faces of the circuit board,

the peripheral side extends at least 180 degrees around the two opposing faces of the circuit board with the LEDs mounted on opposite peripheral sides of the circuit board to one another,

the LEDs mounted inside the through holes are in between the LEDs mounted on the opposite peripheral sides of the circuit board to one another,

the device comprises an LED driver that is configured to power the plurality of LEDs,

the plurality of LEDs comprise at least two groups of LEDs, and the LED driver is configured to switch or modulate the powers sent to the groups of LEDs at differing times to one another to simulate a flickering flame.

2. The lighting device of claim **1**, further comprising an end cap upon which the circuit board is mounted.

3. The lighting device of claim **2**, wherein the two opposing faces of the circuit board are orientated vertically when a bottom of the end cap is placed on a horizontal surface.

4. The lighting device of claim **2**, further comprising a diffusion envelope which is mounted on the end cap, envelops the circuit board, and diffuses light from the LEDs.

5. The lighting device of claim **2**, wherein the end cap comprises a power supply to which the circuit board is electrically connected.

6. The lighting device of claim **5**, wherein the end cap comprises a solar panel for powering the power supply.

7. The lighting device of claim **5**, wherein the power supply is electrically connected to the LED driver.

8. The lighting device of claim **7**, wherein the LED driver is mounted on the circuit board.

9. The lighting device of claim **1**, wherein the two opposing faces are each in the shape of a candle flame, the shape being roughly rectangular with a height of twice a width of the shape, and the shape being narrowed towards a top of the shape, wherein the peripheral side extends all around the shape.

10. The lighting device of claim **9**, wherein the LEDs mounted to the peripheral side are spaced around at least 180 degrees of the shape.

11. The lighting device of claim **1**, wherein the plurality of through-holes comprise a line of at least three through-holes in which LEDs are mounted along an axis of symmetry of the circuit board.

12. The lighting device of claim **1**, wherein the circuit board comprises conductive tracks that carry electrical current to and from the LEDs.

13. The lighting device of claim **12**, wherein the circuit board is a printed circuit board.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 10,161,583 B1
APPLICATION NO. : 15/708897
DATED : December 25, 2018
INVENTOR(S) : Stobart et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

The following information should be included:
"Foreign Application Priority Data
June 23, 2017 (GB) 1710069.4"

Signed and Sealed this
Ninth Day of April, 2019

Andrei Iancu
Director of the United States Patent and Trademark Office